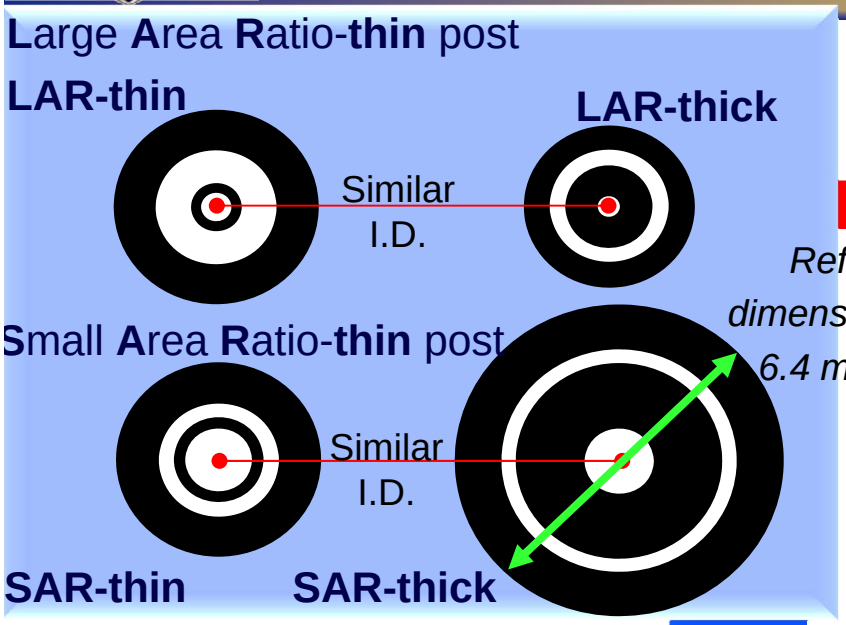
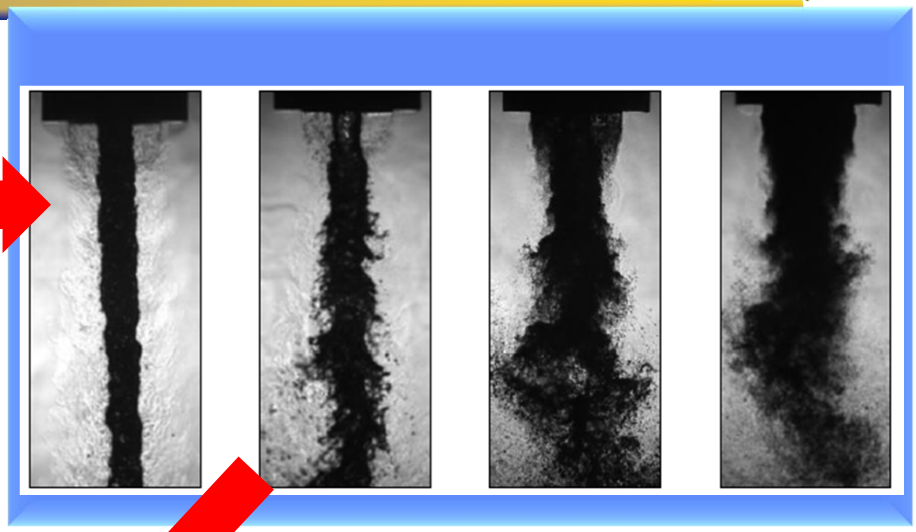
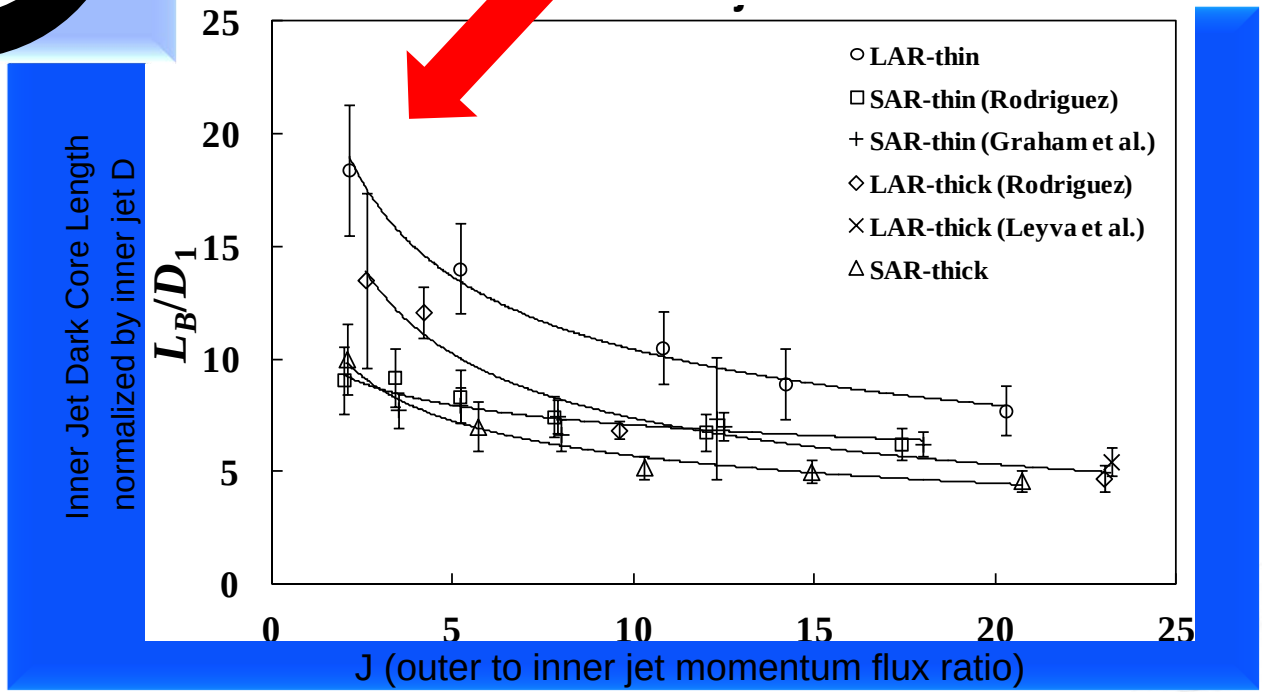
Culmination of Coaxial Injector Mixing Studies:

Ivett Leyva, Doug Talley, Juan Rodriguez, Sophonias Teshome, Dustin Davis





- 4 geometries
- Wide range of operating conditions
- With and without acoustic perturbations



Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
SEP 2012		**00-00-2012 to 00-00-2012**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Culmination of Coaxial Injector Mixing Studies	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air Force Research Laboratory,Wright Patterson AFB,OH,45433**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Presented at the 2012 AFOSR Space Propulsion and Power Program Review held 10-13 September in Arlington, VA.

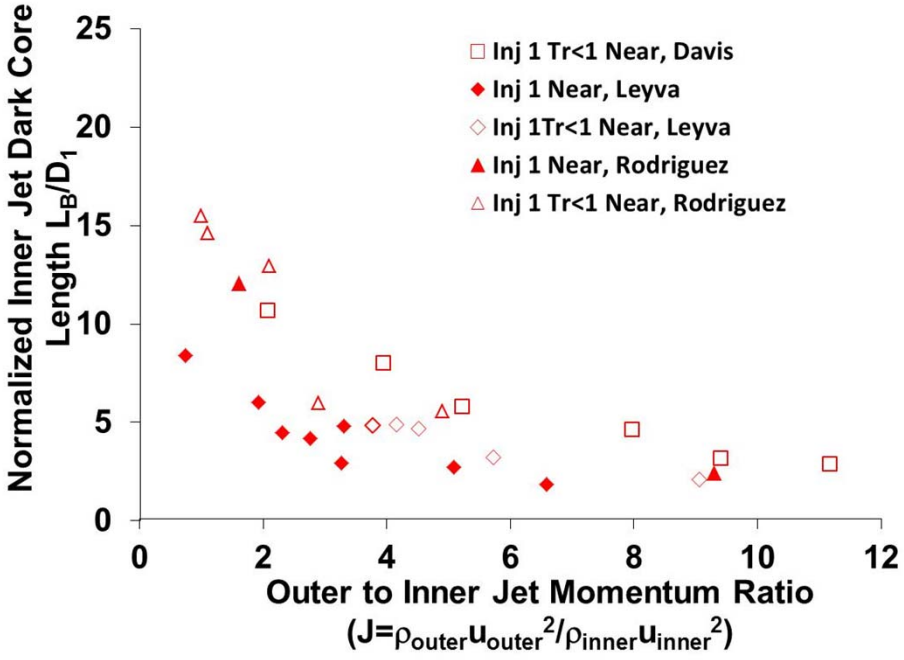
14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**4**	

One geometry – 3 researchers

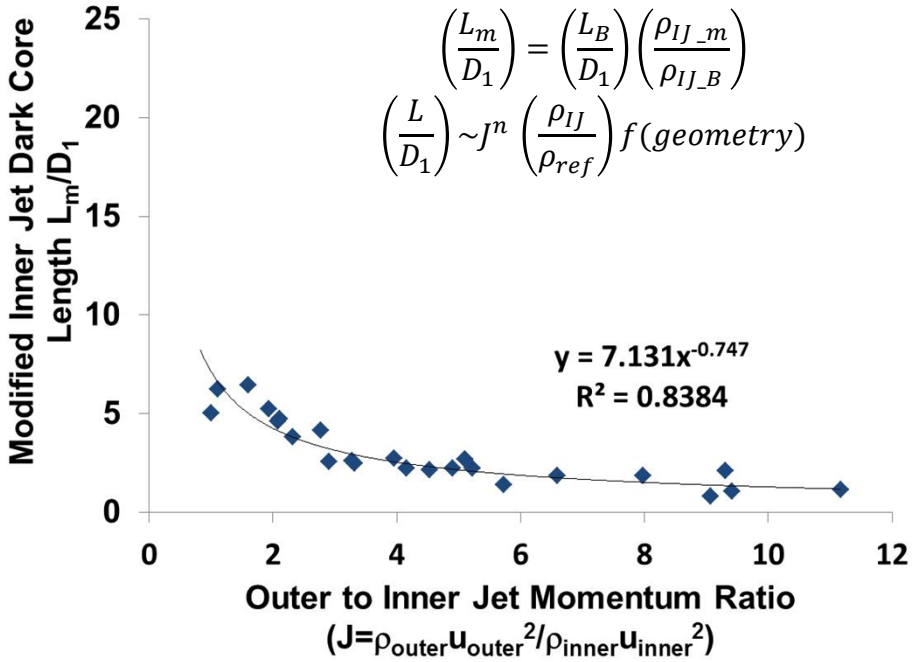
3 Researchers contributed to this baseline plot



NEW --- Collapsed data!

$$\left(\frac{L_m}{D_1}\right) = \left(\frac{L_B}{D_1}\right)\left(\frac{\rho_{IJ\_m}}{\rho_{IJ\_B}}\right)$$

$$\left(\frac{L}{D_1}\right) \sim J^n \left(\frac{\rho_{IJ}}{\rho_{ref}}\right) f(geometry)$$

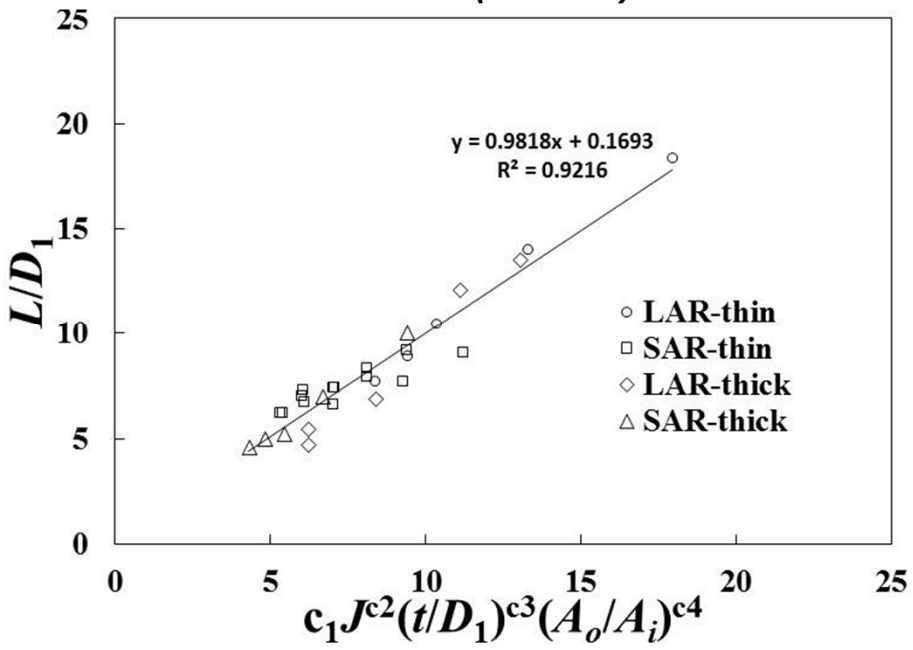


Lots of scatter -- Why? Different inner jet densities

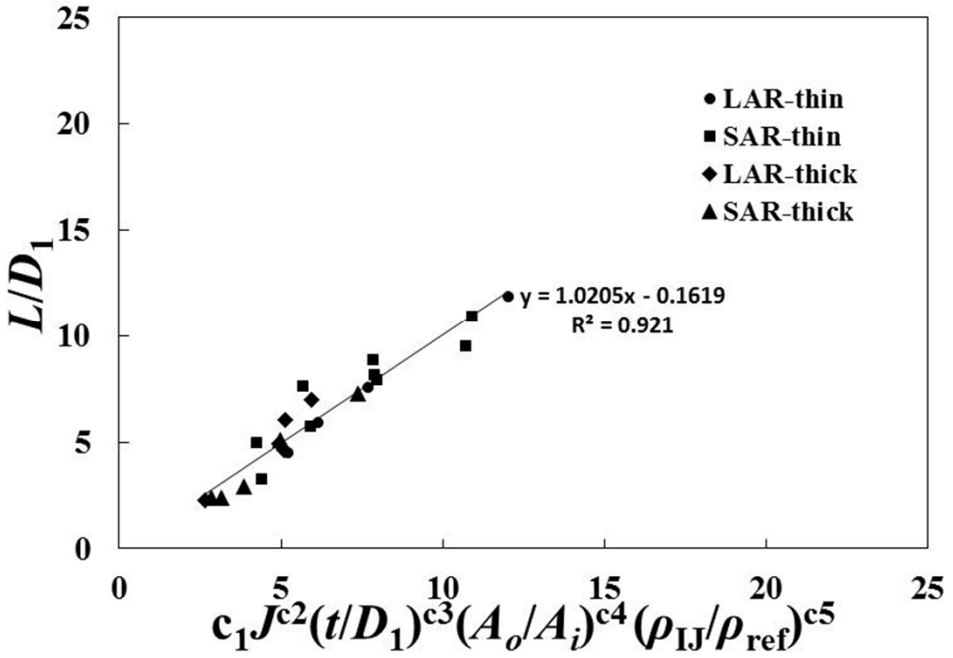
Mixing depends on more than just momentum flux ratio!!

Adding geometry effects …

Subcritical (Pr=0.44)



Supercritical (Pr=1.05)



- *Has characterized mixing for shear coaxial injectors taking into account geometry and flow conditions!*

$$\left(\frac{L}{D_1}\right) = c_1 J^{c2} \left(\frac{t}{D_1}\right)^{c3} \left(\frac{A_o}{A_i}\right)^{c4} \left(\frac{\rho_{IJ}}{\rho_{ref}}\right)^{c5}$$

P_r	c_1	c_2	c_3	c_4	c_5
0.44	9	-0.34	-0.15	0.30	
1.05	9	-0.40	-0.18	0.10	0.51

Other Conclusions

- **Outer to inner jet momentum flux ratio (J) is not the only parameter to characterize mixing in shear coaxial jets - area ratio (Ao/Ai), inner jet post thickness (t), and reduced densities matter!**
  - Found functional correlations for dark core lengths
- **Based on four geometries, mixing is enhanced with increasing J and inner jet post thickness but less efficient with increasing Ao/Ai**
- **Through LES we found relevant St numbers for one geometry for different J values**
- **Helical instabilities were observed for LAR-thin and SAR-thick, SAR-thin geometries at large J for baseline conditions**
- **Applying POD analysis for baseline and acoustically excited cases, able to discern stability characteristics for the different geometries for a wide range of flow conditions**